Federal Aviation Administration

Memorandum

Date: October 20, 2010

To: Manager, Transport Standards Staff, International Branch, ANM-116

From: Manager, Transport Airplane Directorate, ANM-100

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Subject: INFORMATION: Equivalent Level of Safety (ELOS) Finding for Airbus' Project on the Model A340-500 & -600 Airplanes, FAA Project # CP50

ELOS Memo#: CP50-T-P-609

Regulatory Ref: §§ 25.933(a)(1)(ii), 25.1309(b)(1) and 25.1585(a)(9)

This memorandum informs the certificate management aircraft certification office of an evaluation made by the Transport Airplane Directorate on the establishment of an equivalent level of safety finding for the Airbus Model A340-500 and -600 airplanes.

Background

Title 14 Code of Federal Regulations 25.933(a)(1)(ii) requires that "The airplane is capable of continued safe flight and landing under any possible position of the thrust reverser." Airbus declared that Model A340-500 & -600 airplanes will not demonstrate compliance with § 25.933(a)(1)(ii). However, Airbus states that the A340-500 & -600 aircraft thrust reverser design protects against in-flight reverser deployment to an extent that provides a level of safety equivalent to that provided by direct compliance with the rule. Compliance with § 25.933(a)(1)(ii) is intended to completely eliminate all risk of catastrophic in-flight reverser deployment from normal operation. Under § 25.933(a)(1)(ii), any residual risk of catastrophic in-flight reverser deployment would be limited to scenarios involving unusual aircraft configurations, abnormal flight conditions or inappropriate flight crew actions. Therefore, any design intended to provide an equivalent level of safety to the subject rule must limit the residual risk of catastrophic in-flight reverser deployment to a similar level.

In general, the catastrophic risks from other aircraft system hazards are identified and managed through compliance with § 25.1309(b)(1). Therefore, compliance with this standard by the means delineated in the related FAA Advisor Circular 25.1309-1A should be part of any equivalent safety finding utilizing probability that a catastrophic in-flight deployment will not

occur. However, as documented in the docket justification for the subject § 25.933 rule, "A review of the past operating history of airplane engine thrust reversers indicates that fail-safe design features in the reverser systems do not always prevent unwanted deployment in flight. Many of these unwanted deployments are not caused by deficiencies in design but can be attributed to maintenance omissions, wear and other factors that cannot be completely accounted for in the original design and over which the manufacturer generally has no control even when comprehensive maintenance programs are established." This perspective has been re-enforced by an Aerospace Industries Association/FAA review of transport service history, which indicated that many of the reverser in-flight deployment incidents involved inadequate maintenance or improper operations. Other factors such as uncontained engine failure, unanticipated system failure modes and effects, and inadequate manufacturing quality have also played a role in in-service deployment incidents.

Therefore, in addition to the traditional reliability predictions provided in demonstrating compliance with § 25.1309, the equivalent safety finding to § 25.933 will require that the influences which could render that prediction invalid be identified and acceptable means for managing these influences be defined. To this end, compensating design assurance and continued airworthiness features must be provided.

In addition, consistent with the equivalent level of safety finding to § 25.933(a)(1) based on the above demonstration to the reliability requirements, consideration of § 25.1585(a)(9) [Amdt. 25-46] should also be addressed. Section 25.1585(a)(9) states "Information and instruction regarding the peculiarities of the normal operations...must be furnished, together with recommended procedures for-- Restoring a deployed thrust reverser intended for ground operation only to the forward thrust position in flight or continuing flight and landing with the thrust reverser in any position except forward thrust." If appropriate demonstrations to define an acceptable procedure(s) are not deemed warranted due to the accepted reliability for prevention of unwanted deployments in flight, an equivalent level of safety finding to § 25.1585(a)(9) is also required.

Applicable regulation(s)

§§ 25.933(a)(1)(ii), 25.1309(b)(1) and 25.1585(a)(9)

Regulation(s) requiring an ELOS

§§ 25.933(a)(1)(ii) and 25.1585(a)(9)

Description of compensating design features or alternative standards which allow the granting of the ELOS (including design changes, limitations or equipment need for equivalency)

The thrust reverser actuation system architecture has three independent lines of defense to prohibit inadvertent in-flight deployment of the thrust reverser sleeves. The actuation system has two primary locks per thrust reverser (1 per sleeve). The thrust reverser tertiary lock is the third line of defense to avoid an inadvertent thrust reverser deployment in-flight. It prevents

movement of the translating sleeve in case of failure of the primary locks. The tertiary lock is composed of two electromechanical locks, one on each translating sleeve. No in-flight auto-restow function is incorporated on this aircraft.

In accordance with the guidelines of the advisory material proposed by the Powerplant Installation Harmonization Working Group (PPIHWG), ref. minutes of the 20th PPIHWG meeting, Cannes, France, 933 Task Team - Thrust Reverser Harmonization, Federal Aviation Regulations/Joint Aviation Requirements 25.933 draft rule and advisory material draft 10, phase II, it was demonstrated that in normal operation and throughout the fleet life of the Model A340-500 & -600 aircraft, the risk of an inadvertent in-flight thrust reverser deployment is extremely improbable and does not result from a single failure, regardless of the probability of this failure. The influence of possible latent failures on the required level of safety was also assessed.

The criteria in the advisory material proposed by the PPIHWG includes:

1. A rigorous system safety assessment (SSA) of the thrust reverser control, indication and actuation system, including all interfacing power-plant and airplane systems (such as electrical supply, hydraulic supply, flight/ground status signals, thrust lever position signals, etc.) and maintenance. The reliability assessment included the possible modes of normal operation and of failure, the resulting effect on the airplane considering the phase of flight and operating conditions, the crew awareness of the failure conditions and the corrective action required, the failure detection capabilities and maintenance procedures, etc.; and the likelihood of the failure condition. Consideration was given to failure conditions being accompanied or caused by external events or errors. The SSA was used to identify critical failure paths for the purpose of conducting in-depth validation of supporting failure mode, failure rates, exposure time, reliance on redundant subsystems, and assumptions, if any.

    a. The SSA established that any in-flight thrust reversal does not result from a single failure or malfunction, and

    b. That for configurations in which combinations of two-failure situations result in an in-flight thrust reversal, neither failure is pre-existing, (i.e., neither failure situation can be undetected or exist for more than one flight), and the occurrence of either failure result in warnings or are self-evident to the crew to enable the crew to take necessary actions, and

    c. That for configurations in which combinations of three or more failure situations result in an in-flight thrust reversal, the exposure to pre-existing failure situations is limited so that the maximum time each pre-existing failure situation is expected to be present is related to the frequency with which the failure situation is anticipated to occur such that their product is on the order of 1x10-3 or less. The time each failure situation is expected to be present takes into account the expected delays in detection, isolation, and repair of the causal failures.

2. The structural load paths that affect thrust reversal were analyzed to ensure that unwanted thrust reversal is not anticipated to occur due to failure of a structural load path, or due to loss of retention under ultimate load throughout the operational life of the airplane.

3. The effects of the associated loads and vibration on the reverser system in the case of rotor failure were analyzed to minimize hazards.

Explanation of how design features or alternative standards provide an equivalent level of safety to the level of safety intended by the regulation

Although noncompliant with the regulation, a rigorous system safety analysis of the Airbus Model A340-500 & -600 airplanes has demonstrated the risk of an inadvertent in-flight thrust reverser deployment is extremely improbable and is considered to provide an equivalent level of safety to demonstrating that the airplane is capable of continued safe flight and landing under any possible position of the thrust reverser. In addition, the accepted reliability for the prevention of unwanted deployments in flight makes the procedures for restoring a deployed reverser in flight or continuing flight and landing with an unstowed reverser unnecessary. Therefore this is considered to provide an equivalent level of safety to providing the procedures required by § 25.1585(a)(9).

FAA approval and documentation of the ELOS

The FAA has approved the aforementioned equivalent level of safety finding in project issue paper P-609, titled "Flight Critical Thrust Reverser." This memorandum provides standardized documentation of the ELOS finding that is non-proprietary and can be made available to the public. The Transport Airplane Directorate has assigned a unique ELOS memorandum number (see front page) to facilitate archiving and retrieval of this ELOS. This ELOS memorandum number should be listed in the Type Certificate Data Sheet under the Certification Basis section (type certificates and amended type certificates) or in the Limitations and Conditions Section of the supplemental type certificate. An example of an appropriate statement is provided below.

Equivalent Level of Safety Findings have been made for the following regulation(s):
14 CFR 25.933(a)(1)(ii), Reversing Systems, 25.1585(a)(9), Operating Procedures
(documented in TAD ELOS Memo CP50-T-P-609)

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Date

ELOS Originated by TSS:	Project Engineer Douglas Bryant	Routing Symbol ANM-112